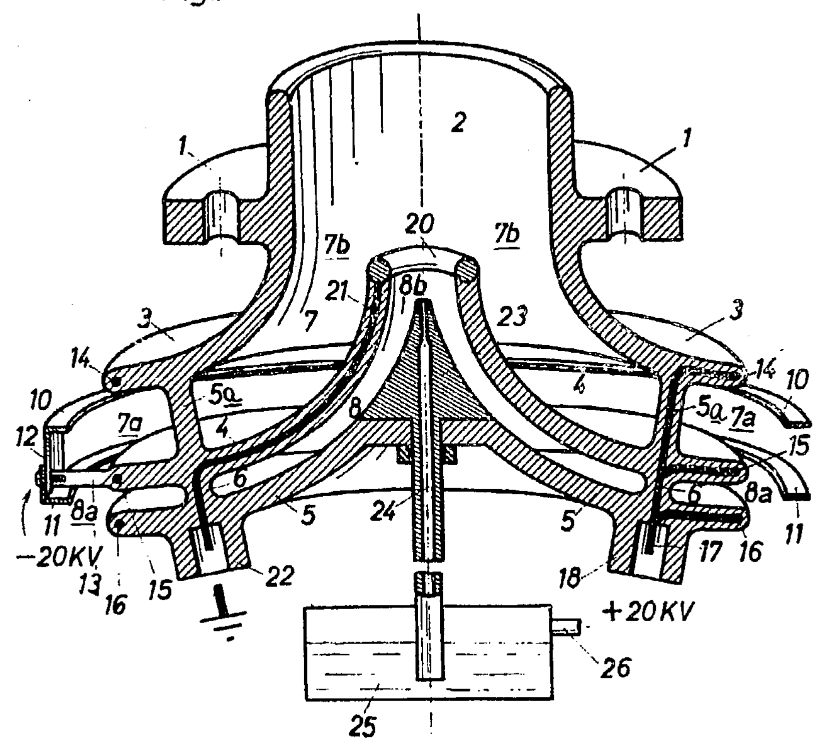
431/2

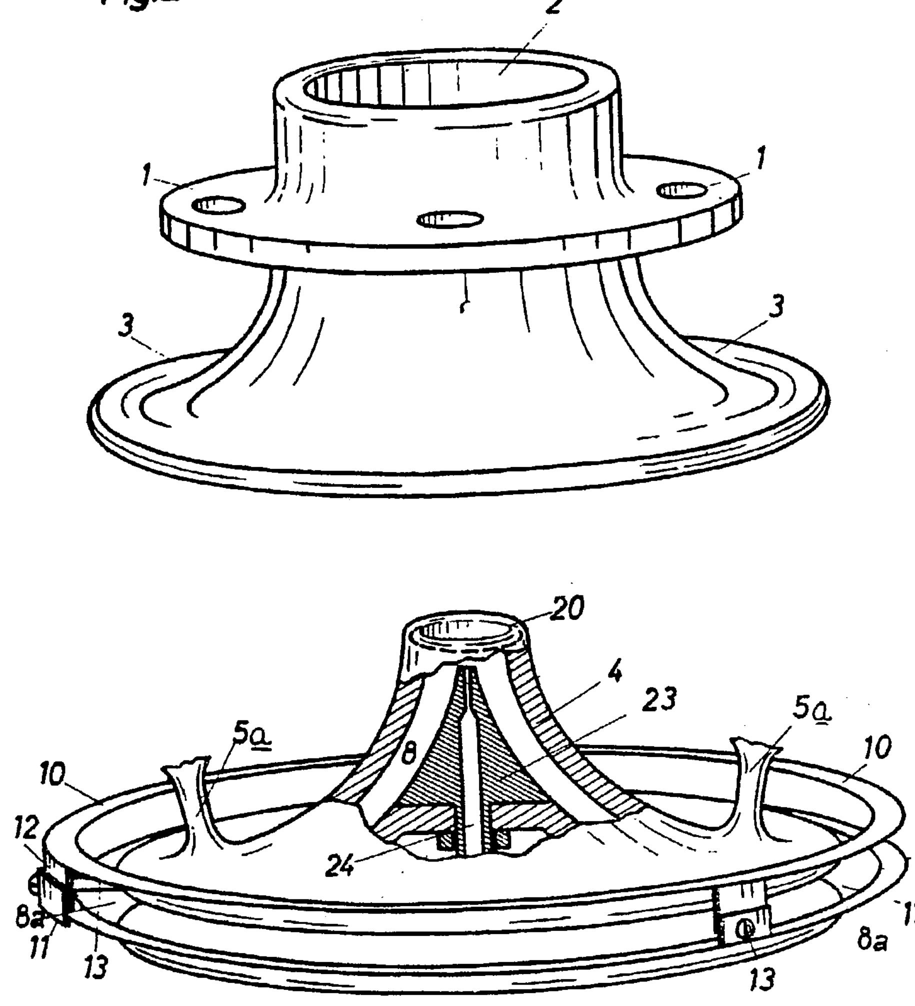
972,302 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

Fig.1



WEST

Fig.2



972,302 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEETS 2 & 3

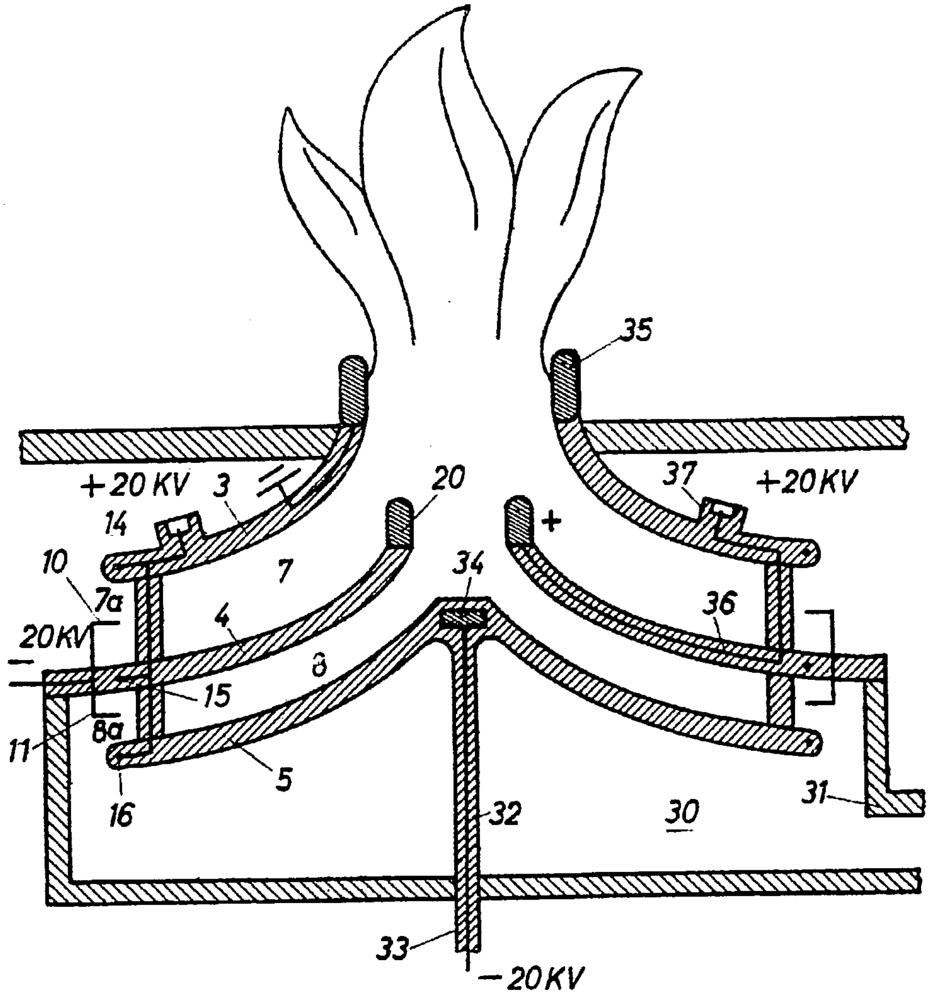
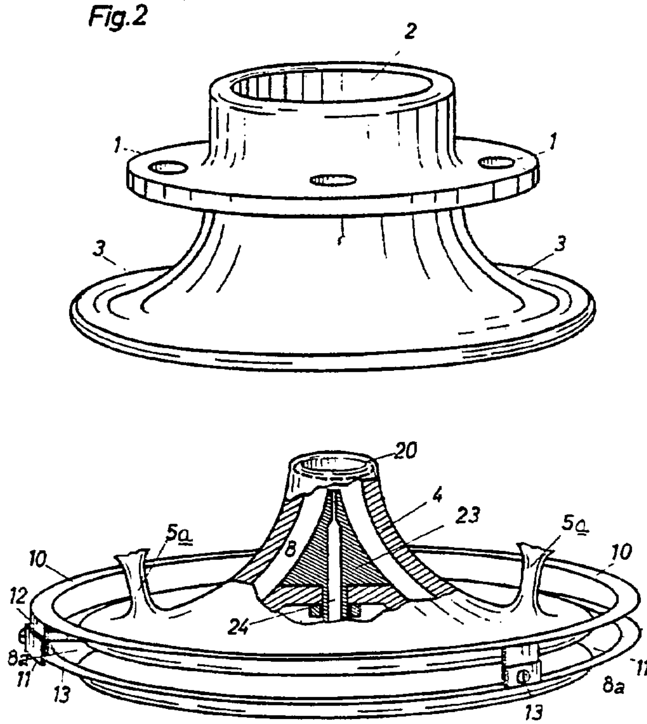


Fig.3

972,302 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 2 & 3

Fig.2



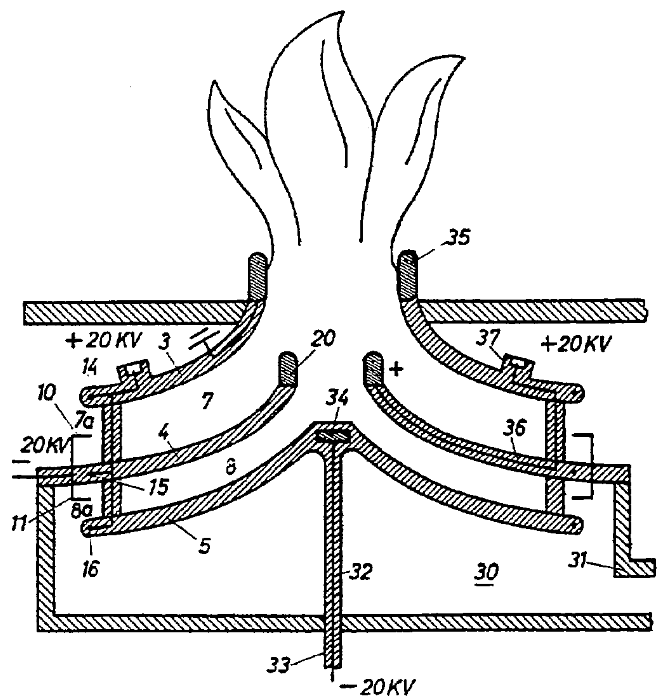


Fig.3

PATENT SPECIFICATION

972,302

972,302

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Burners for Gaseous or Liquid Fuels

I, ALBERTO WOBIG, of 19, Am neuen Felde, Luneburgh, Germany, of German nationality, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a burner for gaseous or liquid fuels.

It is generally usual to drive supply combustion air by forced draught in order to overcome flow resistance and to bring larger quantities of air into the combustion chamber when the boiler is of smaller dimensions. Movement of the combustion air is generally effected by means of drum blowers, fan blowers or like mechanically driven apparatus. Since rotating or other mechanically moved parts are subjected to wear and generate noise, the latter being particularly undesirable for small plants for domestic heating, there is a need for burners in which increased speed of movement of the air of combustion, compared to unforced draught arrangements, is achieved without moving parts.

Now, according to the invention, the aforementioned disadvantages can be mitigated and further important advantages can be achieved by a burner for gas or liquid fuels in which combustion air and/or fuel is ionised comprising at least one spray electrode connectible to a high voltage supply and having a sharp point or a sharp edge, wherein the point or edge points in the desired direction of flow of the air and/or fuel.

With this arrangement, in operation of the burner the "electric wind" effect accelerates the molecules of the air and/or fuel in their desired direction of flow into the boiler. The term "electric wind" is used herein with the meaning attached to it by the following dictionary. *Dictionary of Physics* by H. G. Gray, published by Longmans, Green & Co. (London and New York) first published 1958, page 163—"Electric Wind: Stream of air flowing outwardly from a sharp point or projection on a highly charged electrical conductor. Gaseous molecules become ionised by collision in the intense field near the point and those of the same sign as the conductor are repelled from it, dragging a stream of uncharged molecules with them."

It is found that it is possible utilising this phenomenon to achieve a high efficiency which is comparable with the efficiencies of conventional blowers, and also the ionisation of the fuel considerably improves the ignition of the air and fuel mixture as well as the atomisation thereof. In other words, a larger spacing of the ignition electrodes can be used, so that the chance of ignition is improved because of the longer spark gaps and failure because of pollution of the ignition electrodes is reduced. According to a preferred embodiment which will be described hereinafter, it is possible to recover electrical energy for the ignition sparks from charges in the air mxture after the latter has been accelerated.

In order to obtain a suitable quantity of air throughflow, it is necessary to use an electrode having a sharp point or a sharp edge, herein referred to for convenience as the spray electrode. Such an electrode may be of strip or sheet form, or may be made from metal foil so that the electric wind is set up away from an edge of considerable length. In smaller plants, to replace the strip-shaped electrodes, pointed electrodes may be used. For conventional high voltages, such as 10 to 40 KV., of course only a portion of the air molecules is ionised and accelerated by the "electric wind" effect in a direction away from the point or edge of the spray electrode. However, in practice it has been shown that

[Price 4s. 6d.]

at atmospheric pressure or a suitable higher pressure, the non-ionised air molecules are pulled along in the direction in which the ionised particles move, because the free length of path of ions is in the vicinity of 10^{-5}cm., so that there is a sufficiently large number of collisions between ionised and non-ionised particles whereby the latter are accelerated from their original relatively stationery condition and carried along.

According to a preferred embodiment, at least one electrode complementary to the spray electrode having a large potential difference therefrom is provided downstream spaced from the spray electrode. Preferably, the said complementary electrode, which will be hereinafter referred to as the accelerating electrode has an insulated surface so that, with a relatively small gap between the electrodes resulting in a high field strength, arcing between the electrodes is avoided. If the accelerating electrode has a bare surface, resistances would have to be provided in the supply circuit of the electrodes so that the occurrence of sparking and arcing is avoided. However, this would considerably lower the total efficiency of the burner.

Insulated surface

The accelerating electrode or electrodes are therefore preferably insulated, and it or they may surround the space into which the air of combustion and/or the fuel flows as it enters the boiler.

Preferably, the spray electrode and the accelerating electrode or electrodes are connected to a high voltage transformer so that, upon each change of voltage, the alternating field breaks up the accumulation of static charges on the insulator of the accelerating electrode. Such operation with alternating current has the advantage of avoiding the need for expensive high voltage rectifiers. For operating the burner according to the invention, it is sufficient to use a 10 kilovolt transformer such as that required for the ignition of conventional oil burners. For larger quantities of air throughput, it is, of course, possible to use transformers of 40 kilovolt output or higher. Despite the applied alternating field, the air flow streams away from the point or edge in only one direction. The break-up of the accumulated charges on the insulating layer of the accelerating electrodes prevents the electric wind effect from deteriorating.

A.C.

Downstream from the electrodes referred to there may be further similar stages. Each of these stages may consist of at least one spray electrode and at least one insulated accelerating electrode. The stages could comprise a plurality of insulated accelerating electrodes of which at least one has a larger potential than the others. The spacing between the stages should be larger than the distance between the individual electrodes of each stage so that the fields extending from the accelerating electrode of one stage to the spray electrode of the other stage against the direction of flow may be kept small.

According to a preferred embodiment of the burner according to the invention, at least portion of the electric air stream is used for drawing in and/or atomising the fuel. This is possible because, even if only a single arrangement comprising one spray electrode and one accelerating electrode is used, air velocities can be obtained which produce a vacuum at a suction opening for the fuel.

Preferably, the edges of the spray electrodes are directed towards a common point or line of combustion so that an increase in the density of the charge in the air stream is obtained downstream in the vicinity of that point or line. The increase in the density of the charge in the airstream can be enhanced by suitably shaped flow channels for the air stream. For the same purpose, the air stream may be diverted by means of electric fields.

According to the aforementioned preferred embodiment, part of the charge in the air stream can be recovered and utilised for igniting the fuel-air mixture. In this case, one of the ignition electrodes is arranged to collect some of the charges of the ionised air stream. Ignition of the fuel-air mixture then takes place by discharging this electrode to an earthed counter electrode.

Preferably, one ignition electrode is located in the centre of the combustion air stream. The other ignition electrode is annular or tubular and arranged concentrically with the first-mentioned ignition electrode. By suitable choice of size and arrangement of the central ignition electrode or by including at least one capacitor, the capacity of the ignition electrodes can be made so large that, taking into account the spacing from the other ignition electrode, ignition sparking can be set up by means of the self-charging of the central ignition electrode in the ionised air stream. Obviously, and especially for smaller devices in which the recovery of the charge of the ionised air stream is insufficient for ignition, a suitable additional voltage may be applied to the two ignition electrodes. This presents no difficulties because high voltage is available from the high tension transformer. However, in this case the burner according to the invention has the advantage that ignition in the ionised air stream takes place much better than in a non-ionised air stream. With an alternating current supply, rectifiers may be provided which effect positive or negative charging of the ignition electrode from the air stream. Charging of the ignition electrode can be supported by further collecting electrodes or grids located upstream or downstream.

The fuel nozzle which introduces the fuel

into the air stream may constitute a spray electrode.

According to a preferred embodiment, there is provided a frusto-conical guide member of insulating material, preferably ceramic or porcelain, in the bottom edge of which there is embedded an annular accelerating electrode. At a spacing from the bottom edge of the guide member, there is arranged an annular spray electrode having a sharp edge. This edge is directed towards a point on the axis of symmetry of the guide member downstream of the spray electrode. Several guide members may be arranged one coaxially above the other in a pagoda-like construction so that a passage remains between each pair of guide members for the flow of combustion air or the fuel. The passages open into a common orifice. In this arrangement, the suction openings of the passages extend radially whilst the discharge ends of the passages extend axially.

According to a further preferred embodiment, a flame-stabilizing electrode is arranged in the vicinity of the burner tube nozzle, such electrode holding the root of the flame to the burner tube nozzle by virtue of its potential relatively to the ions in the flame.

The accompanying drawings illustrate preferred embodiments of the invention.

In the drawings:—

Fg. 1 is a diagrammatic cross-section of a preferred embodiment of an oil burner according to the invention;

Fig. 2 is a perspective exploded view of the burner according to Fig. 1, but slightly modified;

Fig. 3 is a section through a gas burner according to the invention.

In the Fig. 1 embodiment, there is provided a guide member of ceramic or porcelain comprising a flange 1 for connecting the burner to, say, the door of the kiln, a burner tube nozzle 2, a curved first guide wall 3, a similarly curved second guide wall 4 and a further curved guide wall 5. Between the guide wall 3 and the guide wall 4, supports 5a are arranged, for example, at angular spacings of 120° and between the guide wall 4 and the guide wall 5 there are like supports 6 for maintaining the spacing.

The guide member formed by parts 3-6 is symmetrical about a vertical axis as shown in Fig. 1 but it will be appreciated that the burner could be mounted on a vertical wall and the axis of symmetry would then be horizontal. The guide member comprises an annular gap 7 between the guide walls 3 and 4, such gap opening into ambient space through a radial suction opening 7a and into the burner tube nozzle 2 by means of an axial discharge opening 7b. The guide member has a narrower annular gap 8 between the guide walls 4 and 5, this similarly opening into ambient space through a radial suction opening 8a and into the burner tube nozzle 2 through an axial discharge opening 8b.

At a spacing from each suction opening 7a and 8a there is a bare electrode ring 10 and 11 respectively. The sharp edge of each of these rings is pointed towards the respective suction openings 7a and 8a. These electrode rings constitute the spray electrodes. They are preferably made of tungsten or rhenium foil. The electrodes 10 and 11 are interconnected by means of brackets 12 which may, for example, be provided at angular spacings of 120°. They are held to the guide by means of ceramic spacers 13.

In each marginal bead of the guide walls 3, 4 and 5, is embedded a wire ring 14, 15 and 16 respectively each ring is connected to a terminal 18 for high voltage by means of a common conductor 17 extending through one of the supports 5a and 6. The wire rings 14, 15 and 16 accordingly form insulated accelerating electrodes which co-operate with the spray electrodes 10 and 11. The spray electrodes 10 and 11 are at a large potential difference from the accelerating electrodes 14, 15 and 16, for example 10 kilovolt, or 40 kV as shown in the drawing.

On that annular bead of the guide wall 4 which opens into the burner tube nozzle 2, there is seated a metal ring 20 which is earthed through a conductor 21 and a terminal 22.

On the guide wall 5 there is seated an approximately conical metal member 23 having a bore 24 for supplying the fuel, for example oil. The oil is sucked from a reservoir 25 in which it is preferably kept under pressure through a supply line 26.

The operation of the burner illustrated in Fig. 1 is as follows:

One terminal of a high tension transformer is connected to the spray electrodes 10 and 11 and the other terminal is connected to the terminal 18 for the accelerating electrodes 14, 15 and 16. The earthed central tapping of the high tension transformer is connected to the terminal 22.

Since the electric field strength is extremely high at the sharp edges of the spray electrodes 10 and 11, for example 10^7 volts per centimetre, electrons are emitted from the edges of the spray electrodes 10 and 11 during a half wave of the applied alternating voltage and these stream away from the spray electrode due to the electric wind effect. During the other half wave, electrons are drawn in from the surrounding air, and positive ions are driven off from the edges. Both positive and negatively charged particles collide with and accelerate air molecules and an electric wind is produced during both half waves. As the charged particles carry along the non-ionised mole-

cules an intense air stream streams away from the spray electrodes 10 and 11 towards the suction openings 7a and 8a. This air stream is strongly accelerated by the insulated accelerating electrodes 14, 15 and 16. By a suitable choice of the spacing of the spray electrodes 10 and 11 from the accelerating electrodes 14, 15 and 16 and by reason of the fact that each spray electrode is faced by two accelerating electrodes arranged symmetrically to the direction of movement of the stream, the major portion of the ionised gas molecules and the carried along non-ionised gas molecules are diverted from the accelerating electrodes 14, 15 and 16 and are driven into the annular gap 7 and 8, respectively.

A strong air stream which draws the fuel out of the bore 24 and atomizes it, discharges from the discharge opening 8b of the annular space 8. A portion of the ionised gas molecules gives their charge to the metal member 23. During operation of the burner with direct current, the metallic member 23 will accordingly be charged positively or negatively. When the charging is sufficiently large, sparking to the metallic ring 20 is set up. This sparking is further facilitated by the remaining ions in the fuel-air mixture. Another strong air stream which supplies the required air of combustion leaves through the discharge opening 7b.

Thus, in the Fig. 1 embodiment the metallic member 23 and the metallic ring 20 serve as ignition electrodes. However, the metallic member 23 also serves as an additional spray electrode by virtue of its potential difference to the metallic ring 20, the metallic ring 20 then assuming the function of an accelerating electrode. This ensures a particularly advantageous swirling of the atomised fuel with the atomising air leaving the discharge opening 8b and with the air of combustion leaving the discharge opening 7b.

In the Fig. 1 embodiment, a velocity of the combustion air of over 20 metres per second, and an air throughput of about 200 cubic metres per hour can, for example, be obtained with a diameter for the spray electrodes 10 and 11 of about 15 cm., and an operating voltage of 10 kilovolts. The total current consumption of the burner amounts to 16 watts. The air throughput is sufficient to burn about 10 kg. of heating oil per hour. The total height of the burner amounted to about 10 cm. The resultant velocity of the air stream and the air throughput quantity principally depend on the spacing between the spray electrodes and the accelerating electrode, the sharpness of the sharp edge of the spray electrode and the applied voltage. Accordingly, it is of particular advantage if the spray electrode is in the shape of a strip or a foil of uniform thickness because this permits an increase in the radius of curvature of the edge of the electrode upon rounding of the corners in the case of a rectangular section strip due to wear. If insulation ruptures are avoided, the burner operates almost noiselessly. These advantages make the burner particularly suitable as a miniature burner, for example for heating stoves placed in a kitchen where there is usually insufficient space to apply to the stoves the conventional long burner tubes with blowers.

In the Fig. 2 embodiment, the metallic ring 20 is embedded in the guide wall 4 in an insulated condition, so that an insulated accelerating electrode faces the metallic member 23 serving as a spray electrode.

Fig. 3 is a diagrammatic illustration of a gas burner constructed in a manner similar to the oil burner described in conjunction with Figs. 1 and 2.

A gas such as natural gas is introduced into a vessel 30 through a connection 31. The guide wall 5 of shallow cone-like shape is supported by an insulating rod 32 containing a conductor 33. The conductor 33 leads to a metallic member 34 embedded in an insulating manner in the tip of the guide wall 5. The upper side of the vessel 30 is formed by the guide wall 4.

The gas in the vessel 30 is driven by the electric wind effect into the suction opening 8a of the annular gap 8 under the action of the electrode ring 11 and the complementary or accelerating electrodes 15 and 16. The surrounding air is driven into the suction opening 7a of the annular gap 7 similarly, due to the co-operation of electrodes 10 and 14, 15.

A metallic ring 35 is seated on the marginal bead of the guide wall 3. In this construction the two parallel stages constituted by the spray electrodes 10, 11 and the accelerating electrodes 14, 15, 16 are followed downstream by a further accelerating stage which is formed by the insulated electrode 34 and a bare metallic ring 20 at the apex of the wall 4. Accordingly, one terminal of the high voltage source is connected to the conductor 33. Connection of the metallic ring 20 to the other terminal of the high voltage source is effected through the conductor 36 in the guide wall 4 and through a connecting plug 37. The metallic ring 20 also serves as one of the ignition electrodes and to collect the charge carriers in the ionised gas. The other ignition electrode is formed by the earthed metal ring 35.

WHAT I CLAIM IS:—

1. A burner for gas or liquid fuels in which combustion air and/or fuel is ionised comprising at least one spray electrode connectible to a high voltage supply and having a sharp point or a sharp edge wherein the point or edge points in the desired direction

of flow of the air and/or fuel.

2. A burner according to claim 1, wherein the spray electrode is of ribbon sheet, or strip form.

3. A burner according to claim 1 or 2, in which at least one accelerating electrode having an insulated surface is provided downstream of and at a spacing from the said spray electrode, the accelerating electrode being maintained in operation at a large potential difference from the spray electrode.

4. A burner according to claim 3, in which the insulated accelerating electrode or electrodes surround a space into which the combustion air and/or fuel are blown.

5. A burner according to any of claims 1 to 4, in which the spray electrode and the accelerating electrode or electrodes are connected to a high tension transformer so that, by means of the alternating field, the accumulation of static charges on the insulator of the accelerating electrode is broken up during each change in voltage.

6. A burner according to claim 4, in which additional stages each including at least one spray electrode and at least one accelerating electrode are arranged downstream from the space.

7. A burner according to claim 6, in which the accelerating stages each comprise a plurality of insulated accelerating electrodes of which at least one has a larger potential difference relatively to the other and in which the spacing between the accelerating stages is larger than the spacing between the spray and accelerating electrodes of each stage.

8. A burner according to claim 1, in which at least a portion of the accelerated combustion air serves to draw in and/or atomise the fuel.

9. A burner according to claim 1 in which the sharp edges of a plurality of spray electrodes are directed on to a common point or line of combustion so that an increase in the charge density in the air stream is achieved at a region downstream from the spray electrodes.

10. A burner according to claim 9 in which the increase in the charge density in the said region is assisted by suitably charged guide members for the air stream.

11. A burner according to claim 10 in which the increase in the charge density in the air stream is assisted by deviation of the air stream by means of electric fields.

12. A burner according to claim 11 in which an ignition electrode for igniting the fuel-air mixture collects the charges of the ionised air stream and in which ignition of the fuel-air mixture is effected by a discharge between this electrode and an earthed counter-electrode.

13. A burner according to claim 12 in which the ignition electrode is located in the centre of the stream of combustion air and in which the counter-electrode is ring-or tube shaped and arranged concentrically with said ignition electrode.

14. A burner according to claim 13 in which the capacity of the ignition electrode is kept so large by a suitable choice of the size and arrangement thereof or by including at least one acpacitor, that, taking into consideration the spacing from the counter-electrode, ignition sparking is set up by the self-charging of the ignition electrode in the ionised air stream.

15. A burner according to claim 14, in which for operation with an alternating current supply, rectifiers are provided which effect a positive or negative charging of the ignition electrode from the air stream.

16. A burner according to claim 15, in which charging of the ignition electrode is assisted by further collector electrodes or grids arranged upstream or downstream.

17. A burner according to claim [illegible] in which the fuel nozzle which introduces the fuel into the air stream is in the form of a spray electrode.

18. A burner according to claim 1 in which there is provided a substantially frusto-conical guide member of insulating material, preferably ceramic or poreclain, in the bottom edge of which is embedded a ring-shaped accelerating electrode and in which, at a spacing from the bottom edge, is arranged the ring-shaped spray electrode having its sharp edge facing the axis of symmetry of the guide member.

19. A burner according to claim 18, in which several guide members are arranged coaxially one above another so that between each pair of guide members there remains a passage for the air of combustion or fuel. and in which these passages open into a common discharge orifice.

20. A burner according to claim 19, in which the guide members are symmetrical about their axis and in which the suction openings of the passage extend radially and the discharge orifice axially.

21. A burner according to claim 20, in which a flame stabilizing electrode is arranged in the vicinity of the burner tube and nozzle, which electrode holds the root of the flame to the burner tube nozzle by virtue of its potential relatively to the ions in the flame.

22. A burner for liquid or gaseous fuel substantially as described herein with reference to the accompanying drawings.

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